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URBANIZATION OF LAND IN THE WESTERN STATES

U.S. DEPARTMENT OF AGRICULTURE ECONOMIC RESEARCH SERVICE

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Airphotos used in this report were provided by Agricultural Stabilization and Conservation Service, U.S. Department of Agriculture, unless otherwise indicated.

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SUMMARY

Great amounts of land were urbanized in the Western United States during 1950-60. Over 71 percent went to dense residential use, 13 percent to open residential use, and smaller percentages to commercial, industrial, recreational, and airport uses. Over 75 percent of the land urbanized had been in cropland and less than 20 percent in pasture and other grassland. Only in the Pacific Northwest were substantial acreages of forest land taken. Very little urbanization came from idle land—cropland apparently went directly into urban use.

As a given area acquired the attributes of a metropolitan complex, less land was used for each new increment of population. Within multicounty Standard Metropolitan Statistical Areas, about 0.05 acre was converted to urban use per capita. Outside the SMSA's, the rate was about 0.13 acre per capita.

This information on the amount and kinds of agricultural land shifting to urban use is needed for interagency surveys of potential development as a basis for projecting quantities and location of land required for development. The three specific types of data needed are amount of land converted in the most recent period for which data are available, prior use of the urbanized land, and relation of land urbanized to population increases.

Since the above types of data are not generally compiled, the most feasible approach was to use airphoto analysis to determine the amount of land urbanized between the population census years 1950 and 1960.

By preliminary examination of airphoto index sheets, 48 counties were selected with average annual shifts of more than 50 acres. These counties were then analyzed by airphoto comparison, and data were obtained on the amounts of cropland, idle land, grassland, and forest shifting to dense residential, open residential, institutional, commercial, industrial, recreational, and airport use.

The coefficients developed in the study appear to provide a general basis for projecting urban land uses. The average relationship of 0.07 acre per capita could be useful as a general guide for planning large heterogeneous areas. More detailed analysis considering additional variables would be needed for detailed planning, and to take account of such factors as local regulations, topography, and stage of urbanization.

NOV 27 1965

URBANIZATION OF LAND IN THE WESTERN STATES

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INTRODUCTION

Additional information has been needed on amount and kinds of rural land shifting to urban uses. Such information can be useful in interagency surveys of potential water development in the Columbia-North Pacific, California, and Colorado Water Resource Regions as a basis for projecting quantities and locations of land required for urban development. 1/

DEVELOPMENT OF THE BASIC DATA

Data are not regularly compiled on acreages of land in urban use. Although general estimates have been made by measuring areas designated as urban by the decennial census of population, this procedure provides statistics only on a State basis. 2/ The most feasible way of gathering specific data appeared to be interpretation of airphotos to determine the amount of land that had changed to urban and associated uses between the population census years 1950 and 1960. These data could then be related to projected population increases to estimate land required for urban development.

Specifically, the objectives of the study were:

1. To measure acreage of land converted to urban uses in the most recent period practicable.
2. To determine prior use of land urbanized.
3. To relate quantities of land urbanized to population increases.

The Economic Research Service has over the past 15 years employed analysis of airphotos for successive time periods to measure changes in land use. 3/ In this procedure, index sheets from airphotos in the scale of 1:63,360 (1 inch to the mile), taken at two different times, are compared to detect changes in land use (fig. 1). These sheets have been prepared for all areas photographed for the Agricultural Stabilization and Conservation Service (ASCS) of the U.S. Department of Agriculture. Although airphoto index sheets are uncontrolled mosaics with some error, they do permit rapid study of a large area

1/ These regions are comprised of the States of Washington, Oregon, California, and Arizona, and parts of Idaho, Montana, Colorado, New Mexico, Utah, and Wyoming.

2/ Frey, H. Thomas, Krause, Orville E., and Dickason, Clifford. Major Uses of Land and Water in the United States with Special Reference to Agriculture: Summary for 1964. Agr. Econ. Report No. 149. Nov. 1968, pp. 67-68.

3/ Dill, Henry W., Jr. "Use of the Comparison Method in Agricultural Airphoto Interpretation." Photogrammetric Engineering. Vol. 25, No. 1, Mar. 1959.

Selection of Counties

A preliminary study was made of the entire survey area, using airphoto index sheets from the national file of ASCS. A preliminary analysis was made of photo index sheets of counties showing urban impact. Although nearly all the counties checked in the preliminary study had some small shift of farmland to urban use—often string development along roads or in areas adjacent to villages—the study was narrowed to 48 counties showing average shifts of more than 50 acres per year. 4/ Three counties were not included because of inadequate photo coverage: Marin, Calif.; Tacoma, Wash.; and Clark (Las Vegas), Nev. Shift of farmland to urban use in San Bernardino, Calif., was measured but eliminated from further analyses because it was judged to be atypical. A number of developments had been laid out but only partially built upon (fig. 2).

Land Use Categories

The next step in the study was to determine the categories of change that could be identified and measured from analysis of airphotos. Four categories of rural land use and seven categories of urban use could be identified using airphoto index sheets with two-power magnification.

Rural Land Use

Cropland—row crops, close grown crops, hay, orchards
Grassland—managed pasture, rangeland
Idle land—unused cropland and pasture 5/
Forest—areas substantially covered by trees

Urban Land Use

Dense residential—houses on small lots, apartments, row houses (fig. 3)
Open residential—one house or less per acre (fig. 4)
Institutional—schools, hospitals, government buildings
Commercial—mainly shopping centers
Industrial—factories, storage yards, auto graveyards, gravel pits
Recreational—parks, golf course, drive-in theaters, race tracks
Airports

The urban use categories were selected to provide the most detailed classification possible using the small-scale airphotos. The classes most subject to error in identification are institutional, commercial, and industrial. While these uses could have been combined into a nonresidential category, they were treated separately to provide an estimate of land requirements for each use.

In addition, two patterns or types of distribution of urbanization were identified and measured: Suburban or "contiguous" development around a city or town (fig. 5) and isolated, unattached "noncontiguous" developments ranging from small groups to larger aggregations of houses (fig. 6).

Photo Interpretation

The counties with significant shifts of farmland were next studied in detail, using airphoto index sheets. The analysis was basically a systematic comparison of a given area for two periods to identify change. To facilitate use of the index sheets, which are generally 20 by 24 inches in size, the early coverage sheets were folded in 4-inch folds for closer inspection of any given item. Shifts of farmland to urban use were outlined on the more recent airphotos with a china marking pencil, and the previous land use (cropland, idle, grassland, and forest)

4/ See table 2 for list of counties.

5/ Includes cropland, some pasture not in production prior to shifting to urban use, and land in farms purchased for speculation and taken out of production pending development.

indicated by symbol. Areas so defined were measured by using a transparent dot grid with 100 dots per square inch. Each dot is equivalent to 6.4 acres, providing a measurement accuracy of ±3.2 acres per square mile.

In general, data obtained from the study include the major shifts of farmland to urban and associated uses. In most of the areas, there is some scattered residential development along roads. This string type of development is difficult to measure on the scale of the photographs used, and measurements were not made. However, in some areas there are substantial amounts of such development which could accommodate some increase in population.

An additional factor affecting accuracy was the use of uncontrolled airphoto mosaics with varying amounts of distortion. More precise area measurement could have been obtained with use of contact prints. However, error due to this lack of precision appears to be random. Any increase in accuracy from use of contact prints probably would not justify the additional time and expense required.

TYPE AND AMOUNT OF URBANIZATION

In the 48 counties studied, about 465,000 acres were found to have shifted to urban uses in an average span of 11+ years (table 1). The greatest amount of urbanization, of course, occurred in the metropolitan complexes of Southern California, the San Francisco Bay area, Seattle, and Portland, plus the Phoenix area (fig. 7-9). A substantial shift of acreage took place in smaller, more isolated centers such as Fresno, Calif., and Spokane, Wash. Lesser amounts of urbanization occurred in a number of counties with smaller cities (fig. 10-15).

Some differences were noted in the patterns of urbanization and the intensity of use between counties in urban complexes and those around smaller cities. To better explore these differences, the 48 counties were classified

Table 1.—Total land use shifts in study counties 1/ 2/

Prior rural use	New urban use							
	Dense residential	Open residential	Industrial	Institutional	Commercial	Recreation	Airport	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Cropland	269,365	31,545	19,875	15,025	15,270	8,335	2,565	361,980
Grassland	43,170	24,200	4,715	2,075	875	1,745	790	77,570
Forest	11,830	5,160	465	---	---	135	---	17,590
Idle cropland	4,480	1,210	1,135	60	90	555	210	7,740
Total	328,845	62,115	26,190	17,160	16,235	10,770	3,565	464,880

1/ Total unweighted changes in 48 counties. Early coverage of counties ranged from 1941 to 1954. Late coverage ranged from 1958 to 1966. Average span of years was 11+.

2/ Figures rounded to nearest multiple of 5.

according to their relationship to Standard Metropolitan Statistical Areas (SMSA's). An SMSA is a county or group of counties defined by the Census Bureau as an entire area in and around a city or community of at least 50,000 in which the activities form an integrated economic and social system. The study counties were classified as (1) being within a multiple-county SMSA, (2) constituting a single-county SMSA, or (3) falling outside any SMSA. Thirteen counties fell in the first group, 11 counties in the second, and 24 in the third (table 2).

Overall, 84 percent of the land urbanized went to residential use. This proportion was fairly consistent for all three classes of counties. However, more of the residential use was of the dense residential type (houses on small lots, row houses, and apartments) for the more highly urbanized areas—80 percent, 67 percent, and 55 percent (of total urban use) for the multiple-county SMSA's, single-county SMSA's, and non-SMSA counties, respectively (table 3). Overall, for each acre going to residential use, about 0.15 acre was developed for commercial, industrial, institutional, recreational, and airport use.

Table 2.—SMSA status of study counties, by State

State	Counties in multicounty SMSA's	Single-county SMSA's	Non-SMSA counties
Arizona	---	Maricopa	Yuma
		Pima	
California	Alameda	Fresno	Imperial
	Contra Costa	Kern	Merced
	Los Angeles	Sacramento	Monterey
	Orange	San Diego	Santa Cruz
	Riverside	San Joaquin	Sonoma
	San Mateo	Santa Barbara	Stanislaus
	Solano	Santa Clara	Sutter
			Tulare
			Ventura
			Yolo
			Yuba
Colorado	---	---	La Plata
			Mesa
			Montezuma
			Montrose
Idaho	---	---	Ada
			Bannock
			Bonneville
Montana	---	---	Missoula
New Mexico	---	---	San Juan
Oregon	Clackamas	Lane	Linn
	Multnomah		Marion
	Washington		
Washington	Clark	Spokane	Yakima
	King		
	Snohomish		

Table 3.–SMSA status of land urbanized by type of urban use 1/

Type of urban use	SMSA status			
	Multicounty SMSA	Single-county SMSA	Non-SMSA	All counties
	Percent	Percent	Percent	Percent
Dense residential	80.0	67.0	54.7	71.0
Open residential	6.0	16.7	25.0	13.1
Industrial	5.3	5.7	7.6	5.8
Institutional	3.4	3.7	4.8	3.7
Commercial	3.5	3.5	2.1	3.3
Recreation	1.3	2.4	5.1	2.3
Airport	.5	1.0	.7	.8
Total	100.0	100.0	100.0	100.0

1/ See footnote 1, table 1, for period covered.

Also, contiguity of urbanization–whether it is generally aggregated or in scattered developments–appears to be related to SMSA status. In the counties found within multiple-county SMSA's, 92 percent of the urbanization was classed as contiguous, while in the non-SMSA counties only 67 percent was so classified (table 4).

PRIOR USE OF LAND

Overall, a high proportion–about three-fourths–of land urbanized was previously devoted to crop production, usually of high-valued, irrigated crops (table 5). In some California counties, all of the land came from cropland. Los Angeles, Orange, Riverside, and Santa Clara Counties used over 90 percent cropland in their expansion–averaging some 14,000 acres annually over the period covered for the four counties. Phoenix (Maricopa County) used almost 80 percent cropland (an average of over 3,000 acres per year). Conversely, in the Seattle area only about 10 percent of land urbanized was formerly cropland (fig. 16). Seattle and Portland were the only areas where significant quantities of forest land were converted to urban use. Most counties showed urbanization of some grassland, the quality varying from productive pasture to near-desert. In only a few counties, such as San Diego and San Mateo, Calif., and Pima, Ariz., did the proportion of grassland urbanized exceed 50 percent (fig. 17 and 18).

Only slightly over 2 percent of the land was idle prior to urbanization. Apparently, the highly productive irrigated cropland in the study counties is kept in production until actually converted to the new urban use.

RELATIONSHIP OF LAND URBANIZATION TO POPULATION INCREASE

In exploring relationships between population increases and urbanization of land, photos were selected to encompass as nearly as

Table 4.—SMSA status of land urbanized by contiguous or noncontiguous development pattern 1/

Development pattern	SMSA status			
	Multicounty SMSA	Single-county SMSA	Non-SMSA	All counties
	Percent	Percent	Percent	Percent
Contiguous	92.0	79.9	67.2	83.0
Noncontiguous	8.0	20.1	32.8	17.0
Total	100.0	100.0	100.0	100.0

1/ See footnote 1, table 1, for period covered.

Table 5.—SMSA status of land urbanized by prior land use 1/

Prior land use	SMSA status			
	Multicounty SMSA	Single-county SMSA	Non-SMSA	All counties
	Percent	Percent	Percent	Percent
Cropland	79.5	79.2	76.1	76.4
Grassland	10.3	24.5	21.3	17.6
Forest	7.3	1.2	1.2	3.9
Idle	2.9	1.4	1.4	2.1
Total	100.0	100.0	100.0	100.0

1/ See footnote 1, table 1, for period covered.

possible the same years as the two most recent censuses of population, 1950 and 1960. Coverage was available from ASCS for most of the counties for 1948-54 and 1956-66. Commercial airphoto coverage was obtained for a few areas where ASCS coverage was not available. In no county were photos available for the precise years 1950 and 1960. Typically, the photos bracketed more years than the censuses.

One method for measuring the degree of coincidence between the photo years and census years is to consider the total number of years spanned by either photos or censuses. For example, with photos for 1948 and 1959, a total of 12 years is involved, of which 9 were covered by either the 1950 or 1960 censuses and by photos. This could be called a 75-percent coincidence.

Using this measure, there was an overall 59-percent coincidence for the 49 counties. Of 647 total years involved, 379 were covered by both photo and census data, 167 were years with photo but not census coverage, and 101 were years with census but not photo coverage. Coincidence ranged from 29 to 91 percent, with over three-quarters of the counties showing a coincidence of over 50 percent.

As an area becomes more populous and takes on metropolitan characteristics, land is used more intensively and less additional surface area is taken for work, living, and service functions for each new person added to the population. Between 1950 and 1960, almost 60 percent of the population increase in the study counties occurred within multicounty SMSA's, while these same counties accounted for only about 40 percent of the land urbanized (table 6). Within the multicounty SMSA's, about .05 acre of land was urbanized per capita increase in population. Over twice as much per capita population increase, almost .13 acre, was urbanized in the non-SMSA counties (table 7).

Table 6.—Average annual land urbanization during study period and population increase, 1950-60, by SMSA status of land 1/

SMSA status	Counties	Average annual conversion of land to all urban uses		Average annual population increase, 1950-60	
		Amount	As a percentage of total	Amount	As a percentage of total
	Number	Acres	Percent	Number	Percent
Multicounty	13	17,550	41.1	340,665	58.9
Single county	11	18,775	43.9	187,675	32.4
Non-SMSA	24	6,410	15.0	50,090	8.7
All counties	48	42,735	100.0	578,430	100.0

1/ See footnote 1, table 1, for period covered.

Table 7.—Land urbanized per capita population increase, by SMSA status of land 1/

SMSA status	Land urbanized per capita for —	
	Residential use	All urban uses
	Acres	Acres
Multicounty SMSA's	.046	.052
Single county SMSA's	.083	.100
Non-SMSA	.102	.128
All counties	.060	.071

1/ See footnote 1, table 1, for period covered.

Variations Among Counties in Urbanization Rates

Individual counties showed substantial variation in land urbanized per capita population increase. Within the multicounty SMSA's, rates varied from .03 acre per person in Los Angeles County to .23 and .25 in Washington and Clark Counties in the Portland SMSA. Single-county SMSA's showed a narrower range—from .05 acre in Pima County (Tucson), Ariz., to .13 acre in San Diego County, Calif. The non-SMSA counties varied from .02 acre in Monterey County, Calif.,—the lowest of any county—to .35 acre in Montrose, Colo. There was also the extreme case of San Bernardino County, Calif., in a multicounty SMSA, with .43 acre urbanized per capita population increase.

Many factors affect the amount of land taken for residential use. Zoning laws and subdivision regulations affect lot sizes. Topography and soils may limit development to certain areas. Some counties have a higher proportion of their population living in apartments and row houses. Commercial, industrial, institutional, and recreational use of land is not as likely to be directly related to population within a given county as is residential use. However, in the aggregate one would expect a fairly close relationship. Business and industry either go where clientele and labor are to be found or attract people to the area after they have been established.

The types of recreational use identified in this study—such as golf courses and drive-in-movies—are oriented to resident population. Some institutional uses, such as colleges or mental institutions, may have a State or regional orientation. However, in the aggregate these factors would tend to be offsetting. For example, one county might have a State penitentiary while another hosts a university.

There is some error inherent in using airphoto interpretation to measure urbanization. As an area approaches a saturation point in the urbanizing process, previously unused lots and other small tracts of land are built upon. Houses and garden apartments are sometimes razed and replaced by high-rise apartments. Such changes can add to an area's capacity to absorb population but may not be identifiable by airphoto interpretation. Also, individual houses built at scattered intervals along rural roads cannot be measured. The houses can be identified, but the amount of land associated with each is nearly impossible to determine from airphotos.

Another source of error is lack of coincidence between census and photo years (see p. 6). Where trends remain fairly constant this probably does not distort the analysis significantly. But if rates of population growth and building increase or decrease within a few years and photo and census years do not coincide, data from the two sources may not be fully compatible.

However, despite fairly wide deviations from the average amount of land urbanized per capita increase in population, simple correlations between land urbanized and population increase were quite high—.89 for both residential use and all urban uses.

Consideration of Other Variables

Several other variables were explored as possibly explaining more of the variation among counties. In using multiple regression, the amount of land taken for residential use was best explained by two variables—absolute increase in population and percentage increase in population. Percentage increase was used to reflect stage of urbanization. As counties become more densely populated, annual percentage increase in population begins to decrease even while absolute annual increases are still large. For example, between 1940 and 1950, the population of San Diego County increased by 26,700 per year, an average annual increase of 9.2 percent. Between 1950 and 1960, the population increased by 47,600 per year but by only 8.6 percent per year (table 8).

Table 8.—Average annual population increases in selected counties, 1920-67

County	Average annual increase in population									
	1920-30		1930-40		1940-50		1950-60		1960-67	
	Amount	Percentage increase	Amount	Percentage increase	Amount	Percentage increase	Amount	Percentage increase	Amount	Percentage increase
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Los Angeles, Calif.	127,204	13.6	55,700	2.6	136,604	4.9	188,708	4.5	116,900	1.9
Alameda, Calif.	13,068	3.8	3,816	.8	26,546	5.2	16,789	2.3	19,510	2.1
San Diego, Calif.	9,741	8.7	7,969	3.8	26,746	9.2	47,620	8.6	23,580	2.3
King, Wash.	7,424	1.9	4,146	.9	22,801	4.5	20,202	2.8	15,520	1.7
Maricopa, Ariz.	6,139	6.9	3,522	2.3	14,558	7.8	33,174	10.0	27,900	4.2

Using the two variables of absolute and percentage rise in population, the following equation was established:

$$Y=123.64 + 0.035\ X_1 + 4.122\ X_2$$
$$(0.003) \quad (2.251)$$

Where: Y=acres converted to residential use (average annual)

X_1=number increase in population (average annual 1950 to 1960)

X_2=percentage increase in population 1950 to 1960.

(Standard error of each coefficient shown in parentheses.)

The coefficient of multiple determination of the equation (R^2) was 0.80. T-values of 12.9 for the X_1 variable and 1.8 for the X_2 indicate significance at the 1-percent and 10-percent levels, respectively.

A regression was also run substituting land for all urban uses as the dependent variable. The resulting equation follows:

$$Y=152.39 + 0.038\ X_1 + 5.566\ X_2$$
$$(0.004)) \quad (2.974)$$

where: Y=acres converted to all urban uses (average annual)

X_1=number increase in population (average annual 1950 to 1960)

X_2=percentage increase in population 1950 to 1960.

(Standard error of each coefficient shown in parentheses.)

The coefficient of multiple determination of the equation (R^2) was 0.74. T-values were 10.6 for the X_1 variable and 1.9 for the X_2, indicating significance at the 1-percent and 10-percent levels, respectively.

These equations help in evaluating the importance of the two variables. However, they have definite limitations for use in projecting urbanization of land at the county level. The large constant factors (123.64 and 152.39) make the equations unrealistic for projecting expected population increases that deviate greatly from the 12,000 average annual increase experienced by the 48 study counties.

Figure 1. – Shift of farmland to urban use as it shows on airphoto index sheets in the Phoenix suburban area. Airphotos on left were taken in 1954; those on right in 1964. Arrows point to the same spot on both sheets. Note the dense residential development in the general area and the golf course below the arrow in the 1964 coverage. Scale 1:63,360.

Figure 2. – Early stage in residential development on cropland and dry rangeland in San Bernardino County, Calif. Upper picture taken in 1953; lower in 1959. Note golf course in upper edge of the 1959 photograph. Scale 1:20,000.

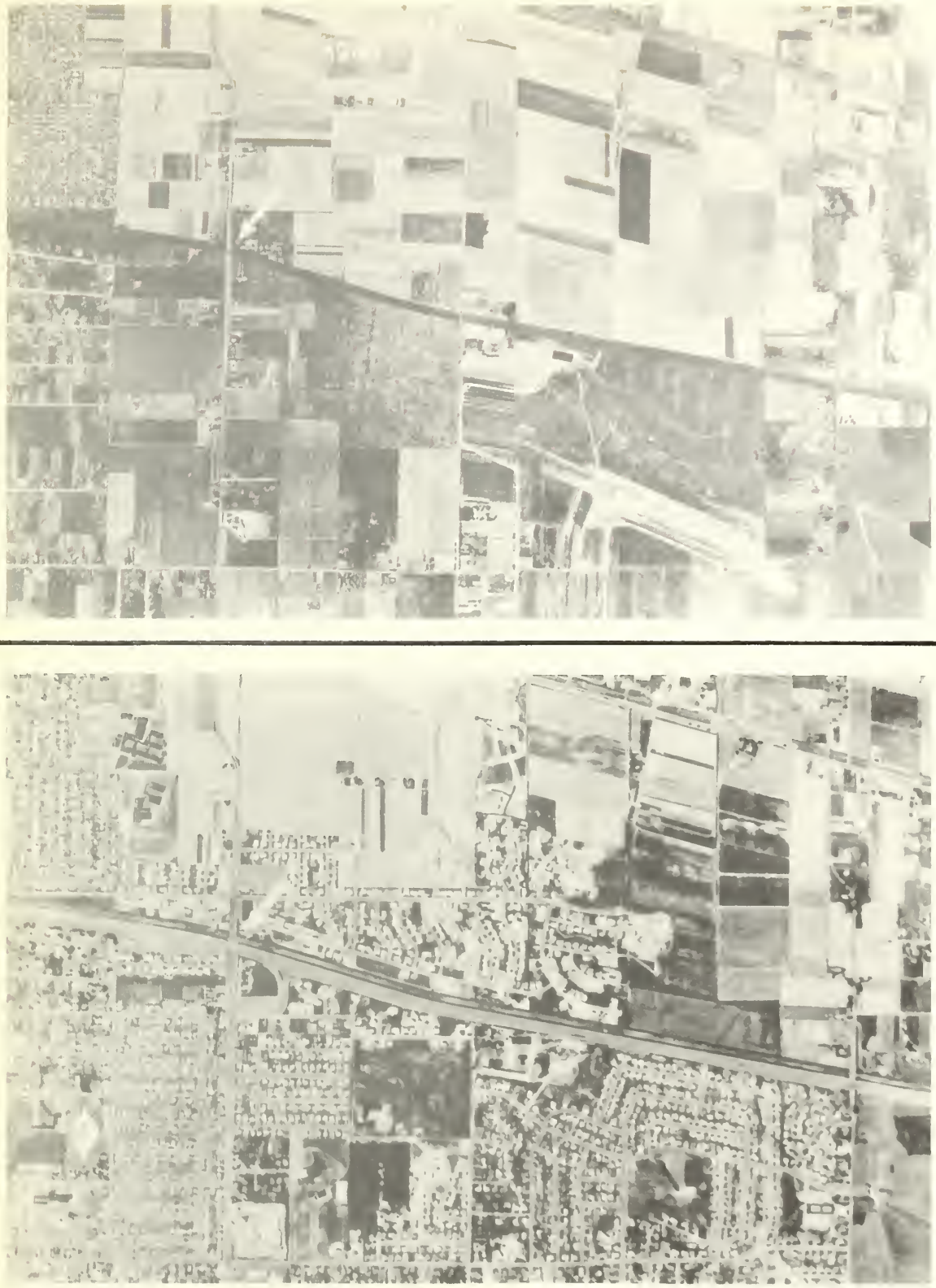

Figure 3. — Typical urban development on farmland on the outskirts of Portland, Oreg. Long arrows show the same point on the airphotos for 1948 and 1963. The broad arrow numbered "2" points at typical "dense" type residential development. Scale 1:20,000.

Figure 4. – Urban development on farmland on the edge of Spokane, Wash. The long arrows show the same point on airphotos taken in 1950 and 1957. The broad arrow points out typical open residential development. Scale 1:20,000.

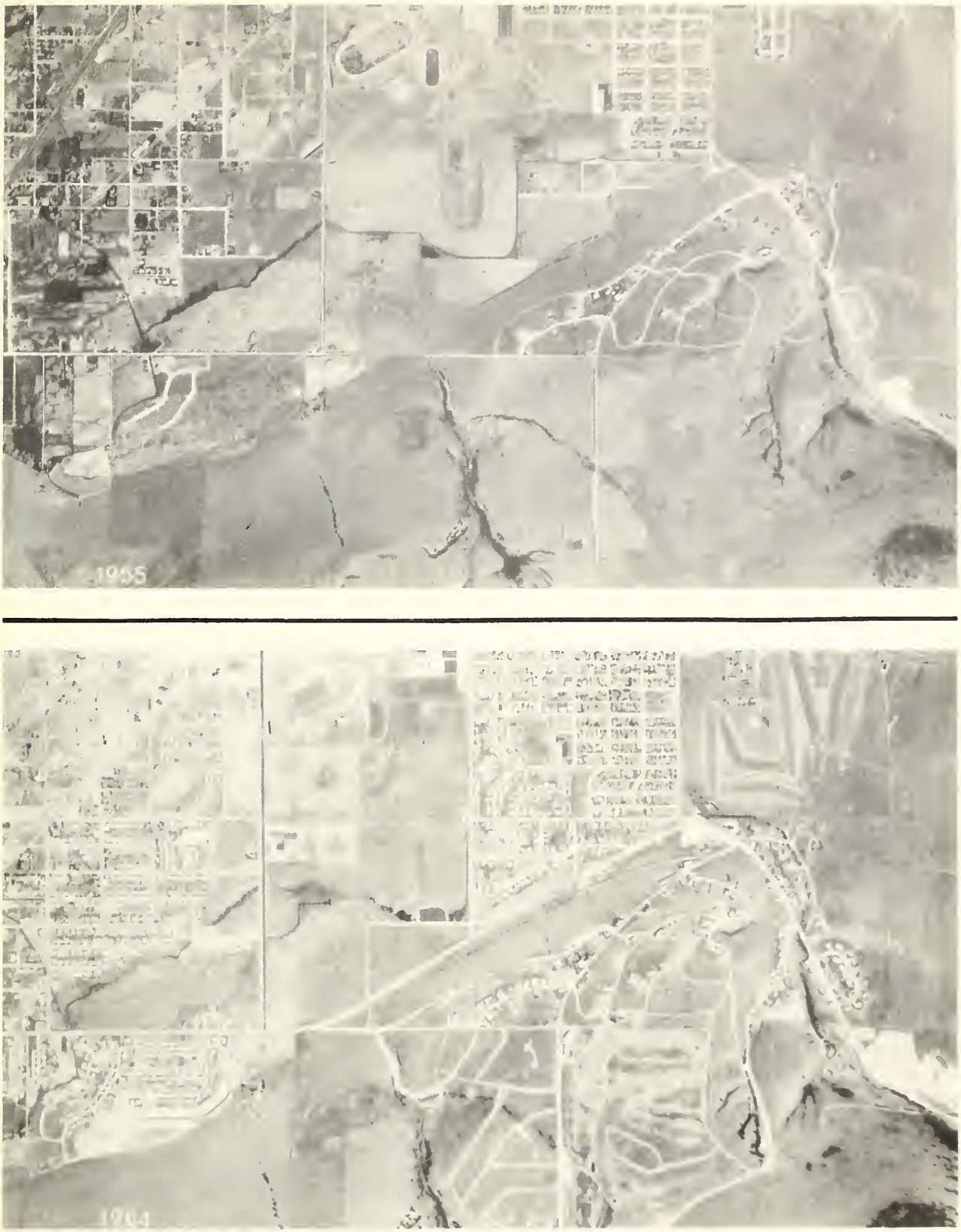

Figure 5. — "Contiguous" urban development on farmland around a small city is illustrated by the above pair of airphotos taken in 1955 and 1964 of Missoula, Mont. Scale 1:20,000.

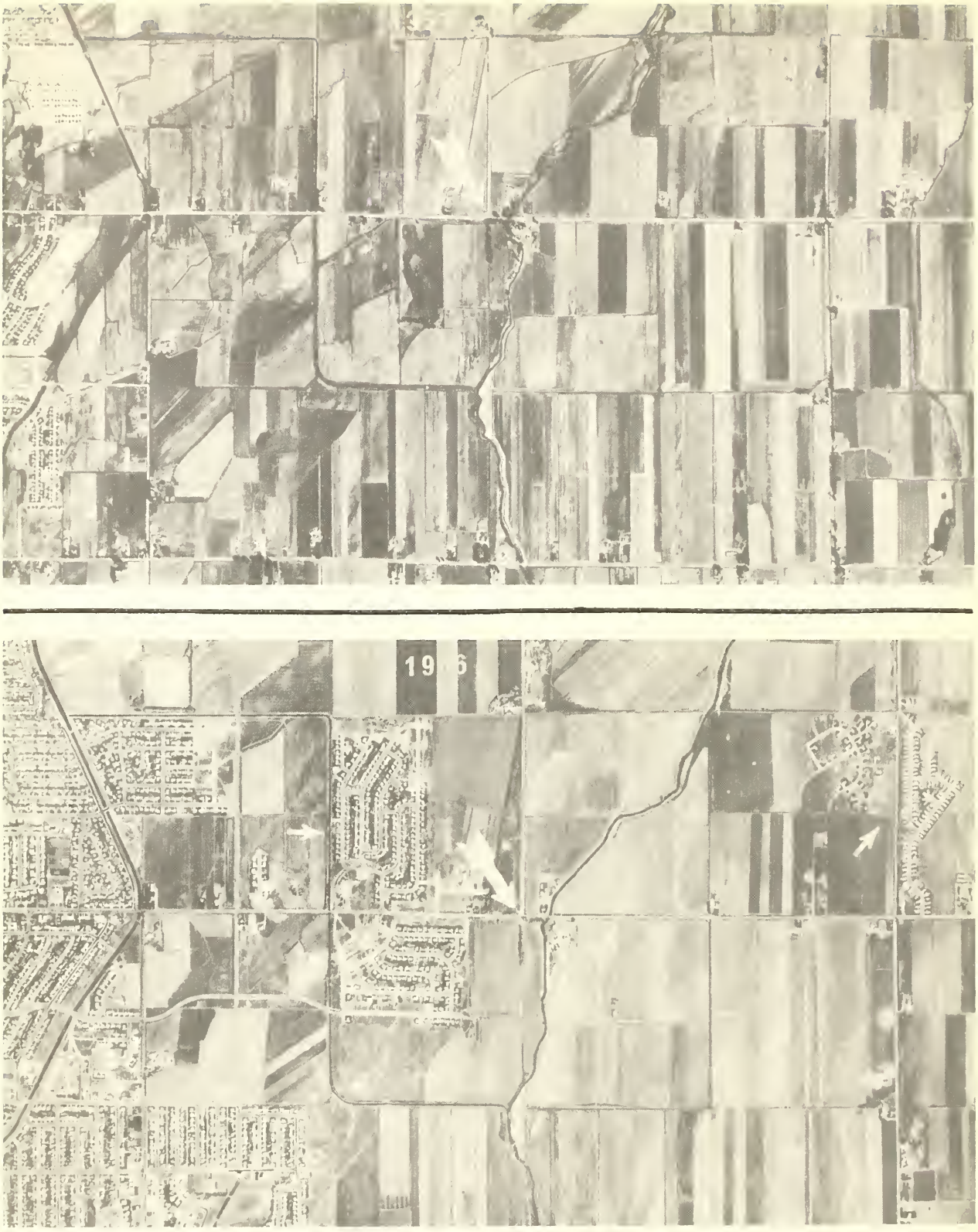

Figure 6. – The above pair of airphotos taken in 1951 and 1966 at Idaho Falls, Idaho, show urban development on farmland. The larger arrows indicate the same point on each photo. The smaller arrows show typical leapfrog or sprawl development. Scale 1:20,000.

Figure 7. – Dense residential development on good farmland in Santa Clara County, Calif., between 1950 (top) and 1963 (bottom). Arrows indicate the same points on the airphotos. Scale 1:20,000.

Figure 8. — Dense residential, institutional and commercial development on orchards in Ventura County, Calif. Upper airphoto taken in 1953; lower in 1965. Note new highway and interchange in lower part of 1965 picture. Scale 1:20,000.

Figure 9. — Shift of cropland and orchards to residential, institutional, and commercial use is shown in the Sacramento, Calif. suburban area. Upper airphoto was taken in 1953; lower in 1964. Arrows indicate same point on both airphotos. The three white patches along the edge of the lower picture are shopping centers. Scale 1:20,000.

Figure 10. – Residential development on farmland around a small city is illustrated by these airphotos of Stockton in San Joaquin County, Calif. The upper picture was taken in 1952; the lower in 1963. Scale 1:20,000.

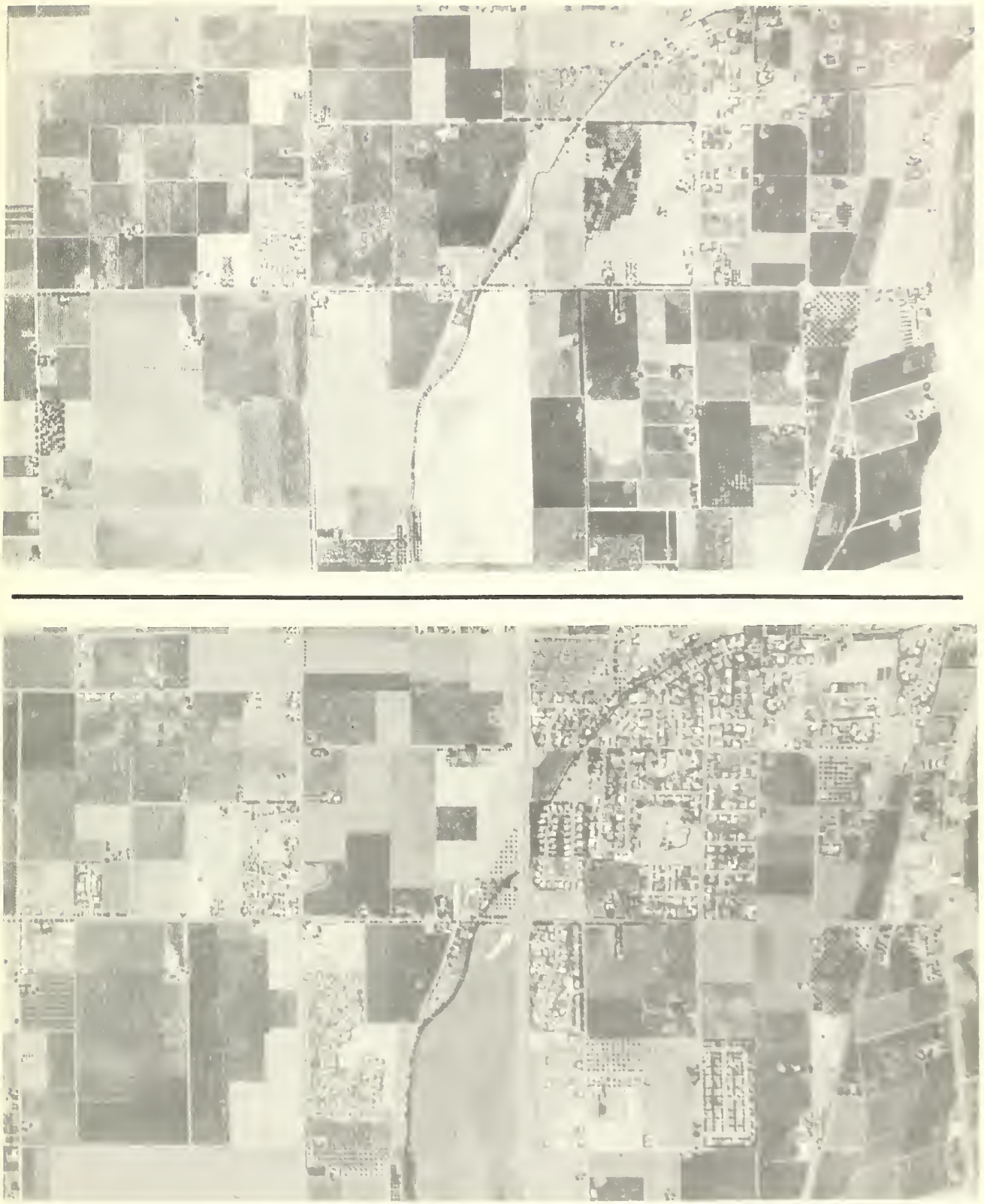

Figure 11. — Urban development on orchards and cropland around a small city, Yuba City, in Sutter County, Calif. The upper airphoto was taken in 1952 and the lower in 1964. Note the separate developed areas on either side of the arrow in the 1964 airphoto. Scale 1:20,000.

Figure 12. – Residential and commercial development on good farmland adjacent to Montrose in Montrose County, Colo. The upper airphoto was taken in 1954, the lower one in 1960. Scale 1:20,000.

Figure 13. — Residential and institutional development on cropland and rangeland around Durango in La Plata County, Colo. The upper airphoto was taken in 1950, the lower one in 1966. Scale 1:20,000.

Figure 14. – Residential development on irrigated cropland and orchards, and dry rangeland around Farmington in San Juan County, N. Mex. The upper airphoto was taken in 1950, the lower in 1962. Scale 1:20,000. (Second photo by Soil Conservation Service, USDA.)

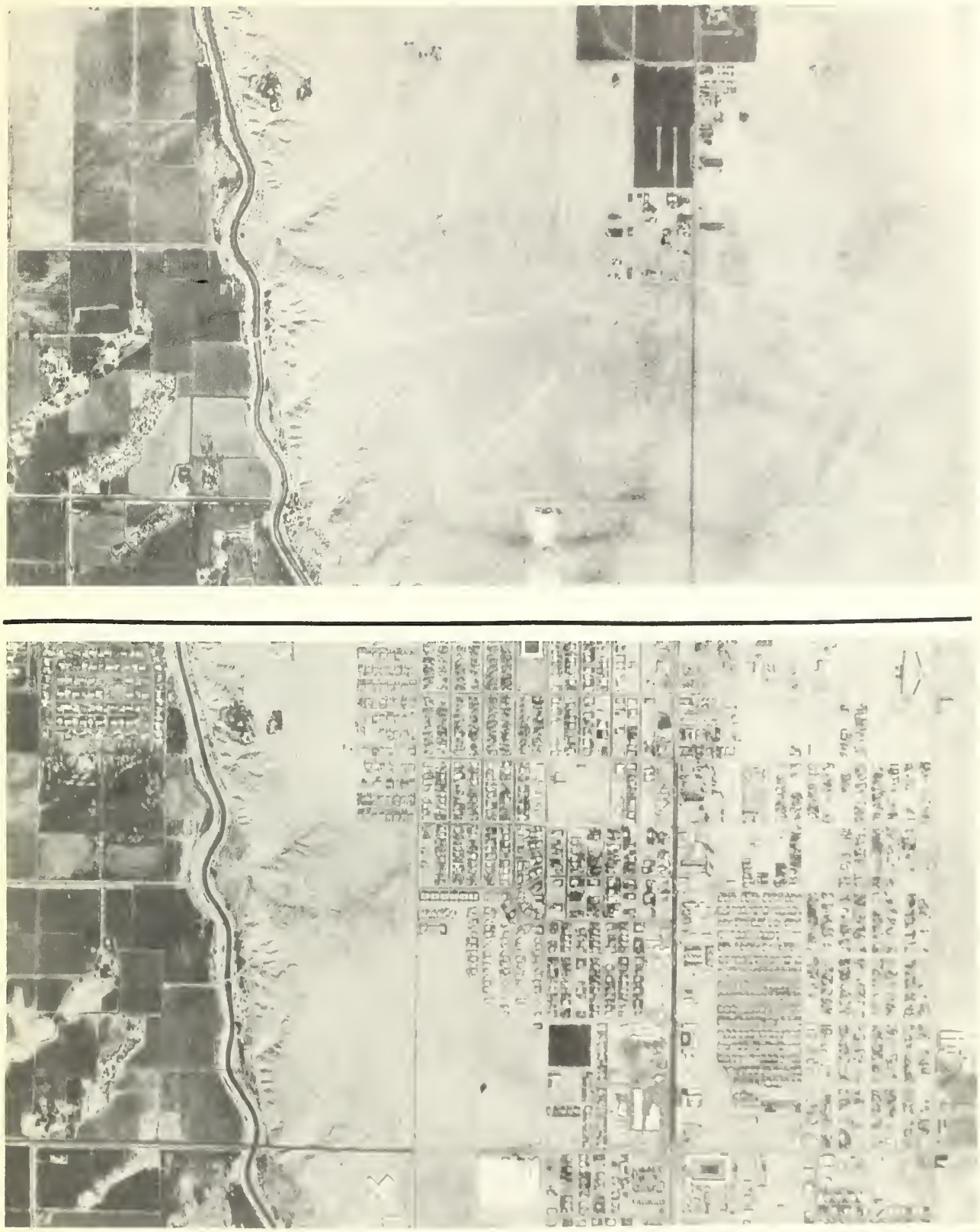

Figure 15. — Residential and commercial development on dry rangeland and irrigated cropland around Yuma in Yuma County, Ariz. The upper airphoto was taken in 1946, the lower in 1958. Scale 1:20,000.

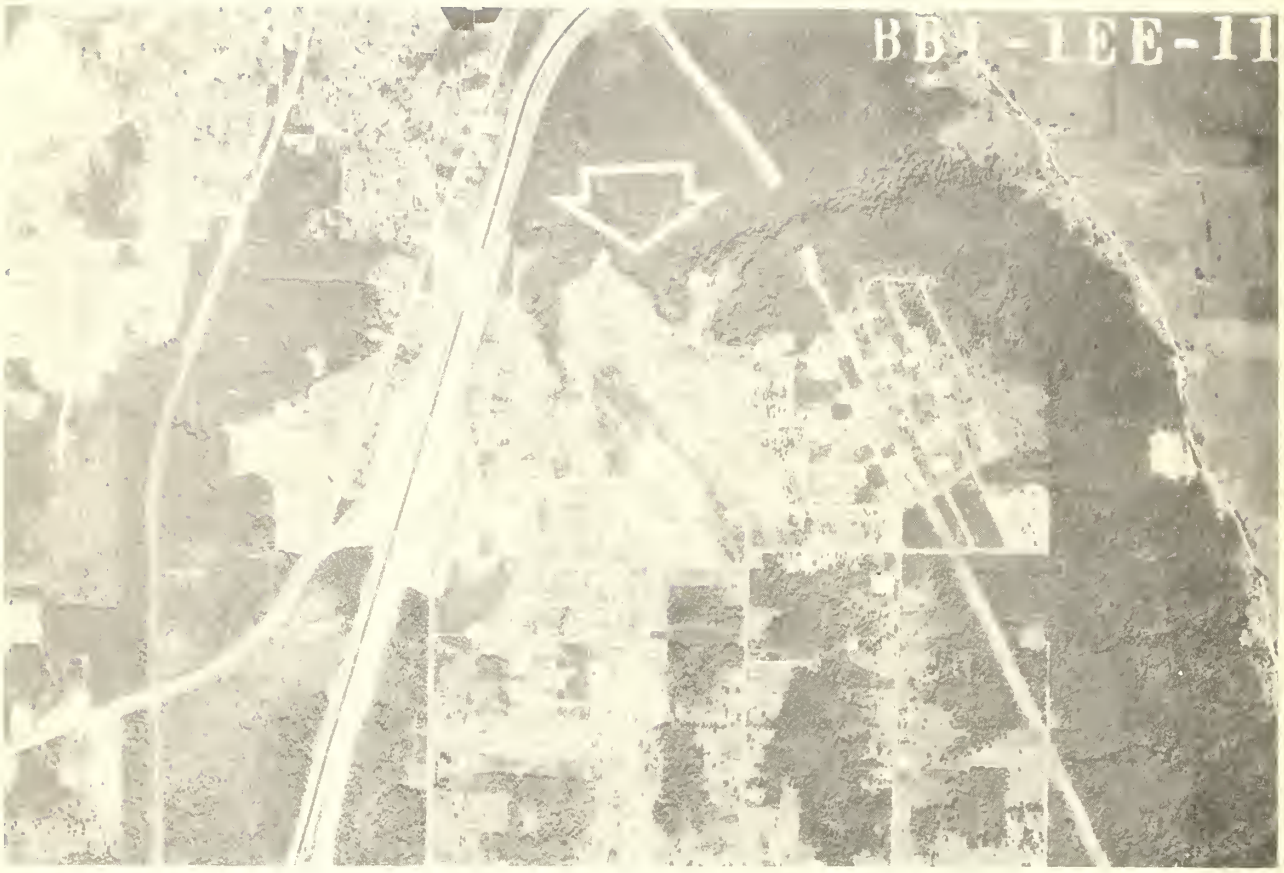

Figure 16. – Urban development on forestland is typical of the Seattle suburban area. The arrow at the top of the airphoto taken in 1964 points out recently constructed open residential development on forestland. Scale 1:20,000.

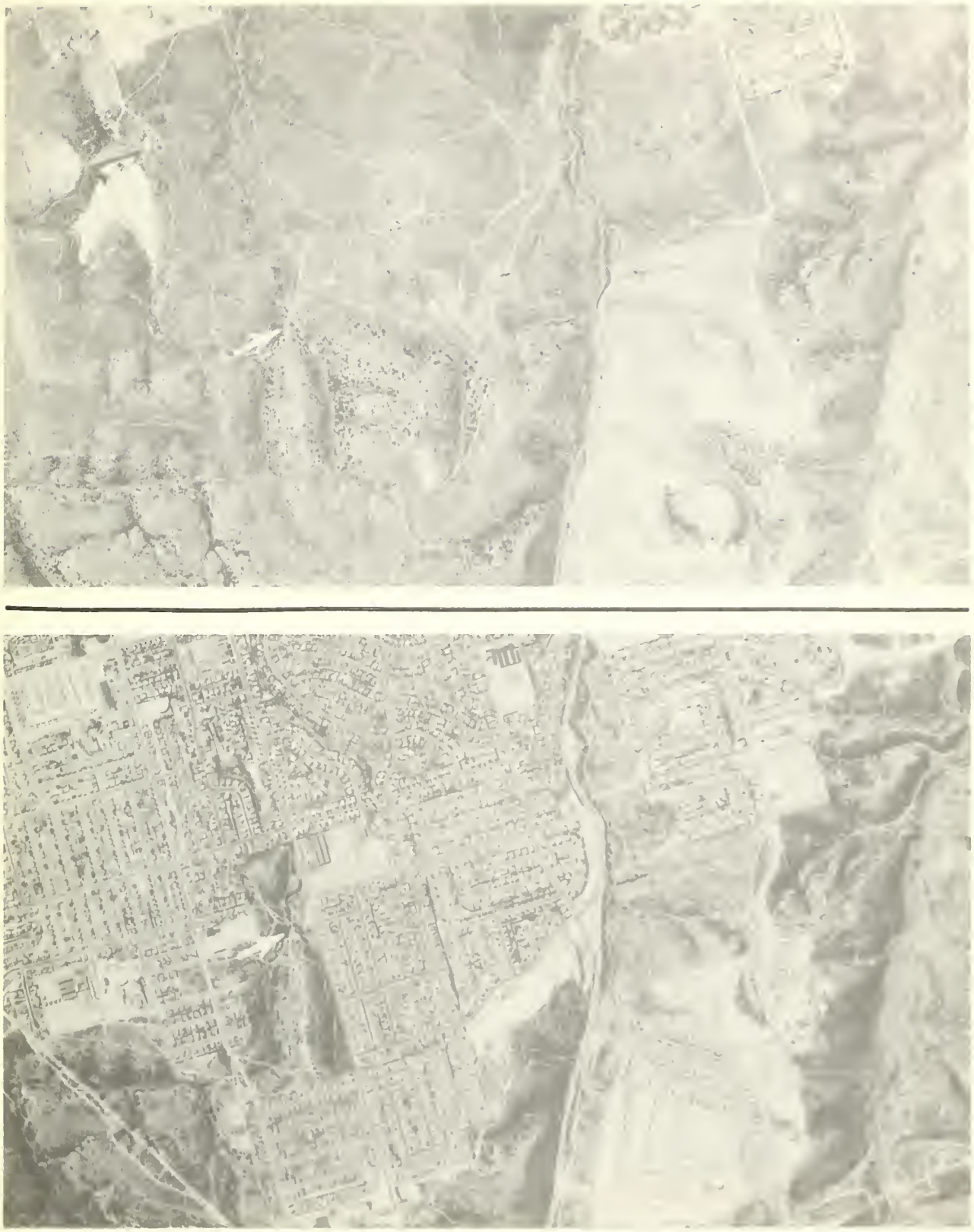

Figure 17. — Dense residential development on range and pastureland in the San Diego, Calif., suburban area. Upper airphoto taken in 1953; lower in 1964. Arrows indicate the same points on both photographs. Scale 1:20,000.

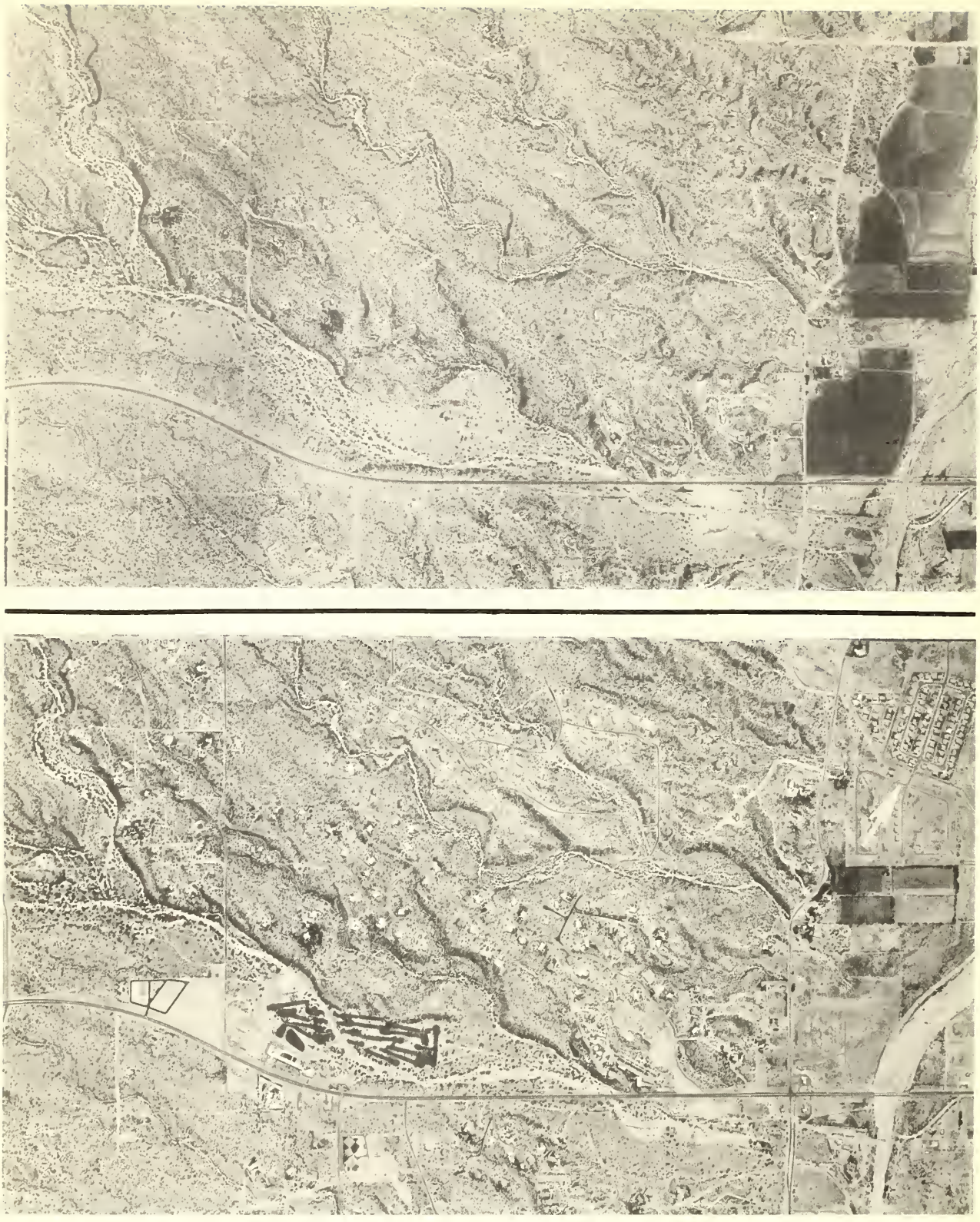

Figure 18. — Open residential development on grassland and dense residential development on cropland (see arrow) are shown on this airphoto of Tucson in Pima County, Ariz. The upper airphoto was taken in 1954, the lower one in 1964. Scale 1:20,000.

APPENDIX

Shifts of land to urban uses, by State and county, for periods of airphoto coverage

State and county	Period of airphoto coverage	Amount of land shifted	Average annual shift
		Acres	Acres
Arizona:			
Maricopa	1949-64	60,120	4,010
Pima	1954-64	6,420	640
Yuma	1941-58	3,170	185
California:			
Alameda	1950-59	9,320	1,035
Contra Costa	1950-59	7,645	845
Fresno	1950-61	10,490	1,050
Imperial	1953-65	720	60
Kern	1952-61	4,510	500
Los Angeles	1954-64	61,425	6,145
Merced	1950-61	1,405	125
Monterey	1949-64	2,105	140
Orange	1953-64	54,805	4,985
Riverside	1954-64	16,850	1,685
Sacramento	1953-64	21,610	1,920
San Bernardino	1953-59	57,750	9,625
San Diego	1953-64	41,220	3,750
San Joaquin	1952-63	3,765	340
San Mateo	1956-64	1,615	200
Santa Barbara	1954-61	4,290	610
Santa Clara	1950-63	33,150	2,550
Santa Cruz	1956-63	450	65
Solano	1952-64	4,550	380
Sonoma	1953-65	6,660	555
Stanislaus	1950-63	6,245	480
Sutter	1952-64	1,035	85
Tulare	1952-61	1,400	155
Ventura	1954-65	17,205	1,565
Yolo	1953-64	2,260	205
Yuba	1952-64	1,765	145
Colorado:			
La Plata	1950-66	1,005	65
Mesa	1954-62	990	125
Montezuma	1954-66	965	80
Montrose	1954-60	640	105

Shifts of land to urban uses, by State and county, for periods of airphoto coverage—Continued

State and county	Period of airphoto coverage	Amount of land shifted	Average annual shift
		Acres	Acres
Idaho:			
Ada	1949-64	5,635	375
Bannock	1949-64	3,220	215
Bonneville	1952-66	2,860	205
Montana:			
Missoula	1955-64	1,910	215
New Mexico:			
San Juan	1950-62	4,070	340
Oregon:			
Clackamas	1948-63	5,910	395
Lane	1952-60	1,860	230
Linn	1948-63	1,900	125
Marion	1948-63	8,320	555
Multnomah	1948-63	7,365	490
Washington	1948-63	10,735	720
Washington:			
Clark	1948-60	2,600	215
King	1954-64	11,495	1,140
Snohomish	1954-64	2,710	270
Spokane	1951-57	3,655	610
Yakima	1949-59	1,110	110

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